



Advanced Power Electronics Interface in Micro-grid Systems

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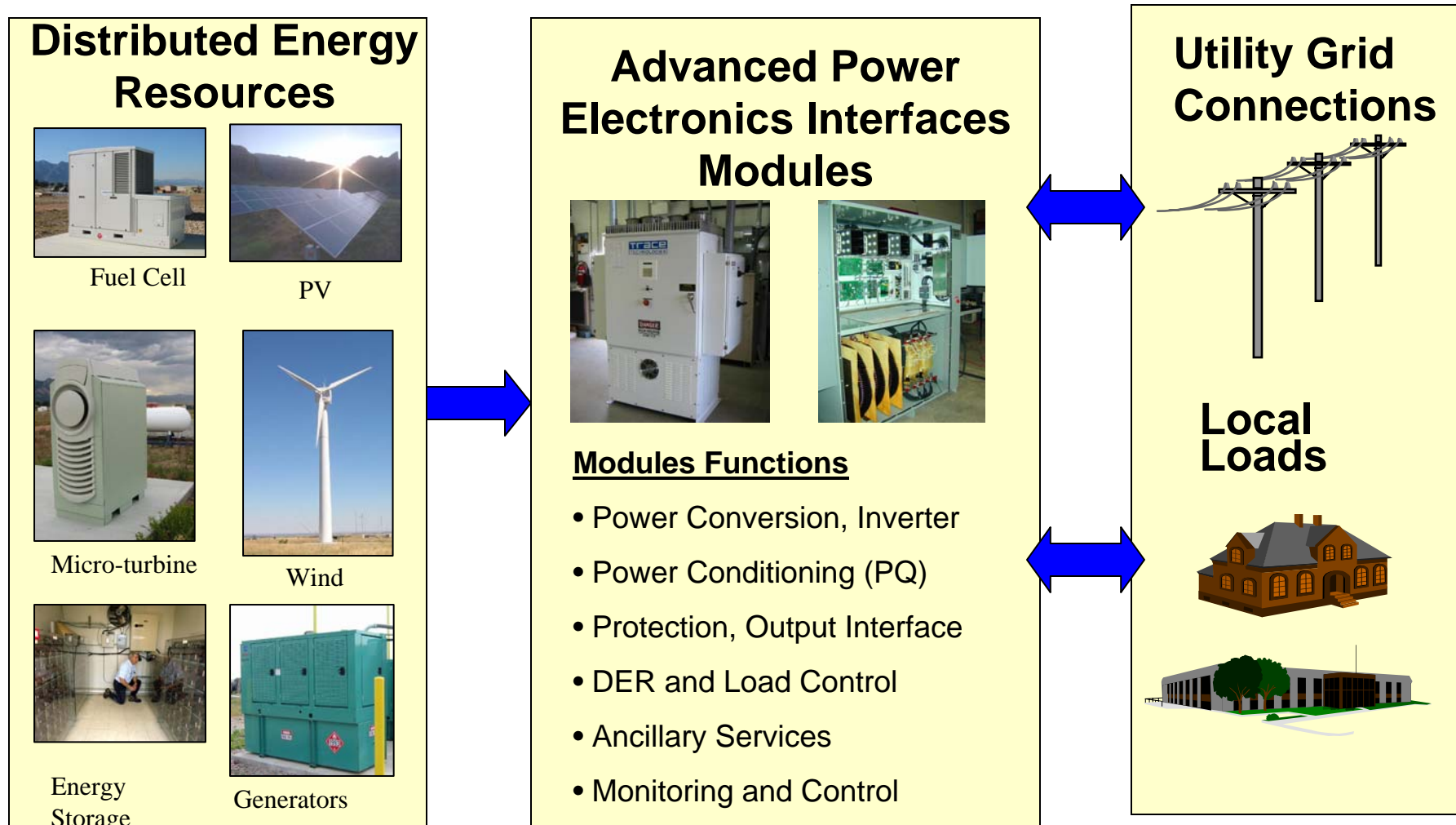
Research Assessment



- ❑ Subject Area : **Micro-grid and Power Electronics (PE) technologies used in Distributed Energy Resources (PIER DER) applications**
- ❑ Objective: **Identify** and **evaluate** research programs in order to **provide guidance to PIER** Integration Research Program and U.S. Department of Energy.
- ❑ Focus : Application of **Inverters, un-interrupted power supplies and energy storage** used in distributed generation and micro-grid systems.

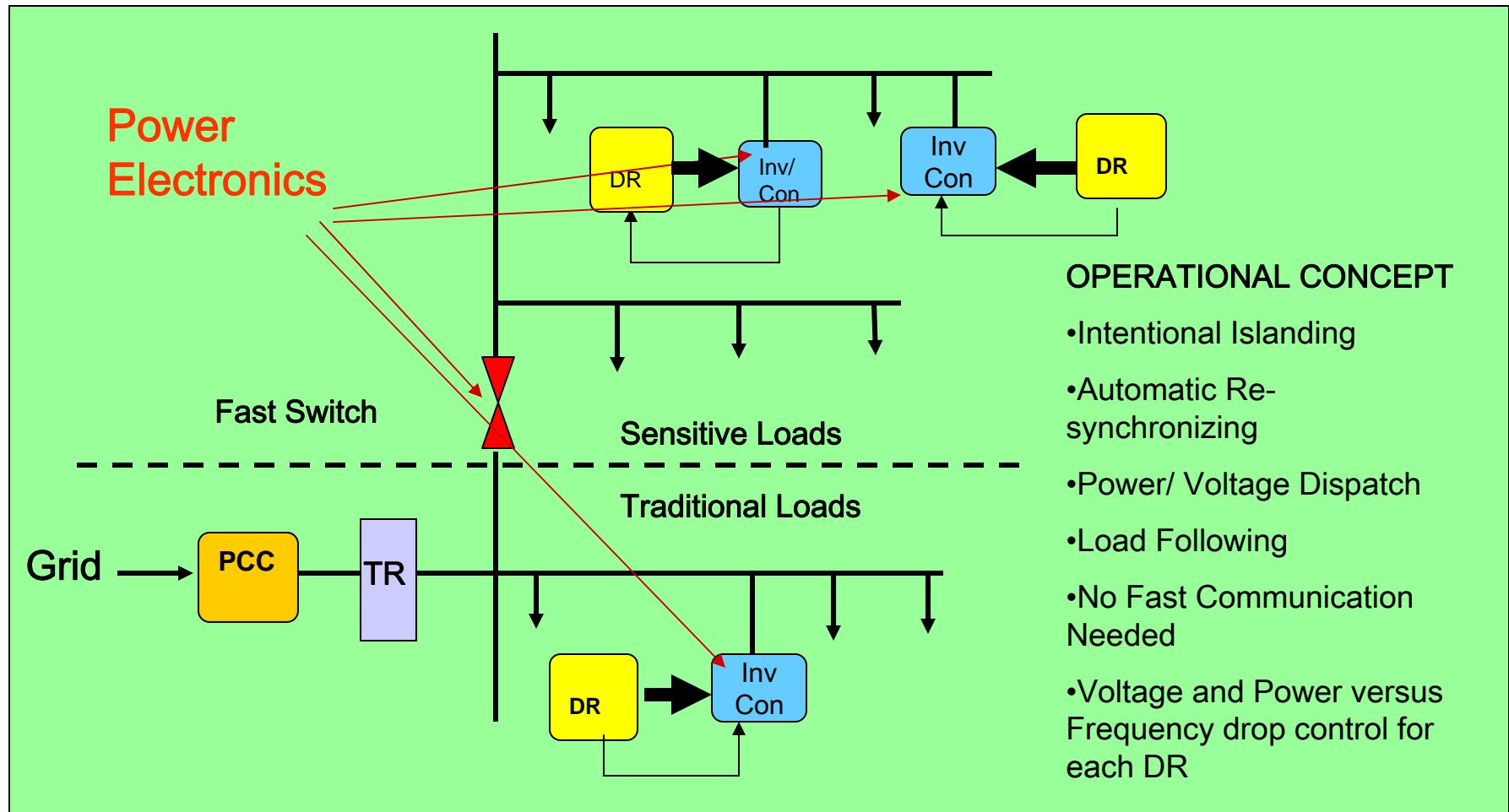
Note: This study was conducted by Navigant Consulting (December 2004 to August 2005)

DER Power Electronic Interface



Source: NREL

CERTS Micro-Grid



PE Basics Specifications

- ❑ PE refers to **devices** (e.g., Insulated Gate Bipolar Transistor and **Silicone Controlled Rectifier**), and associated peripheral **modules**
- ❑ **Convert electrical energy** from one form to a more usable form.
- ❑ Semiconductor-based switch, continuously being improved in term power density and reliability are known as:

<u>Switch Device</u>	<u>Function</u>
Frequency Converter	AC to AC
Inverter	DC to AC
Chopper	DC to DC
Rectifier	AC to DC

PE Problem Statement

- ❑ **Cost** - can account for up to **45%** of the costs of a DER system
- ❑ **Reliability** – Improvement will permit long term commercial penetration of DER using power electronics
- ❑ **Functionality** – Improvement will expand the use of distributed energy

Cost of Power Electronics for DER

- ❑ **Reducing cost** of PE will greatly reduce the overall total cost of DER. Power electronics are part of key DER technologies, and represent a significant portion of the capital cost.

<u>DER Type</u>	<u>DER Capital cost</u>	<u>PE% of Total Cost</u>
•Micro-turbine	\$900- \$1,800	35 to 45 %
•Wind Turbine	\$1,000 -\$4,000	25 to 40 %
•Fuel Cell	\$3,000- \$6,000	10 to 30 %
•PV	\$6,000-\$10,000	10 to 25%

PE Reliability and Functionality Needs

❑ RELIABILITY

- Improve warranties from now **1-5** year to **10-20** years

❑ FUNCTIONALITY

- Improve Power quality,
- Improve Voltage/VAR support,
- Improve seamless connection of backup power, etc.



AEPI High Priority Research

Strategy will be to reduce size and cost while improving efficiency by :

- ❑ **Standardizing** the interface between PE systems and the grid for high production volume.
- ❑ Reducing packaging **size**, lowering **cost** and Increasing **efficiency**.
- ❑ Improving interconnection and **interoperability** of PE components and systems. Achieve “Plug and Play” technology
- ❑ Creating **scalability** and **modularity** of PE systems and components

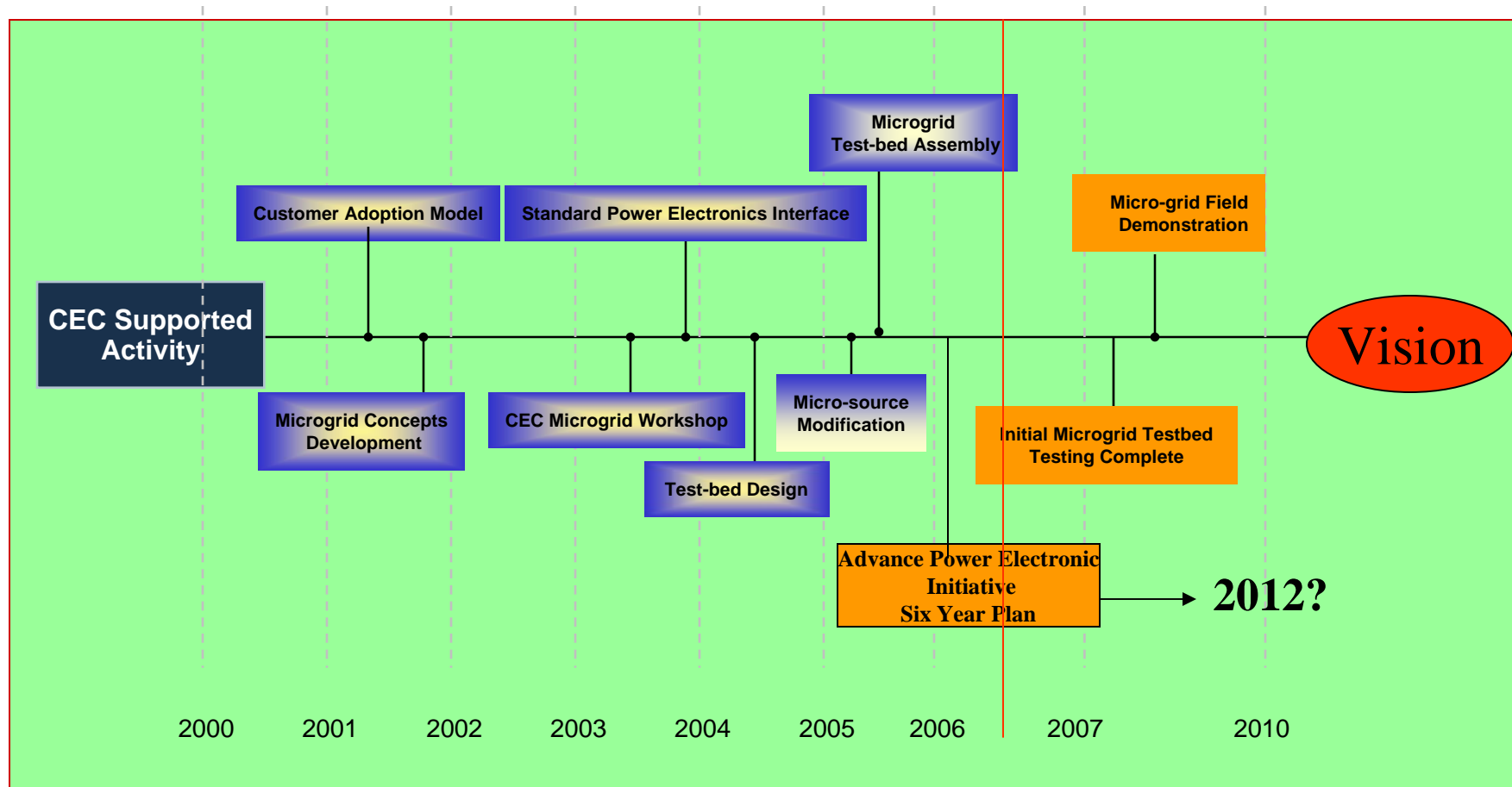


What we are looking for?

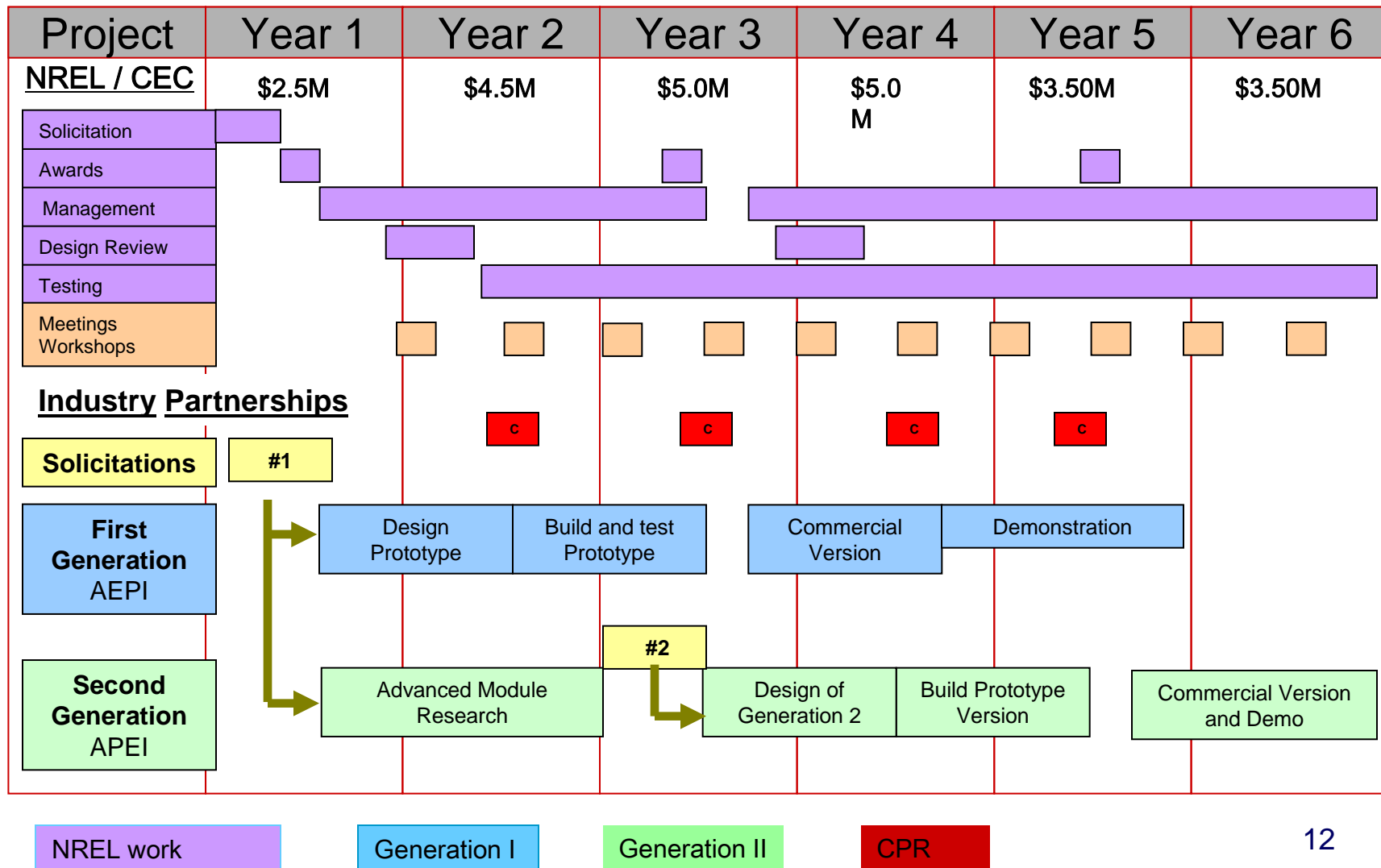
- ❑ **Scalability** (1kW-20kW, 20kW-100kW, 100KW-1MW)
- ❑ **Durability** (10 – 20 year MTFF)
- ❑ **Possibility of Multiple DER operation** in a grid-connected or stand-alone mode for micro-grid applications
- ❑ **Grid support for power quality, load management** (voltage support, VAR support, harmonic correction)
- ❑ **Lowering cost** (\$0.25/W)
- ❑ **Compatibility of communication interfaces** with utility and loads
- ❑ **To Meet National, Regional and local standards & Codes**, e.g., IEEE and UL standards, NEC,FERC, ISO/RTO, etc.



CEC Micro-grid and Power Electronic Program Status



APEI Initiative Timeline





APEI Initiative Cost Table

Six Year Program

Steps	First Generation Solicitation	Second Generation Solicitation	NREL Support	TOTAL 6 Years Funding
Cost	\$6.0M	\$7.0M	\$11.0M	\$24.0M



CEC Projects Status

<u>Projects</u>	<u>Status</u>
CERTS Micro-grid Lab Test	In process
Innovating Rate Making for DER	Completed
Flexible DER Utility Interface	Final Stage
Modeling/Testing effect of Unbalanced Loading and voltage regulation	In Process
Modeling , Research , Planning for APEI Initiative	Start May 2006



Partnerships

- ❑ CEC has an on-going Technology Partnership Agreement with NREL-DOE on *Interconnection, Grid Effects and Tariff Design for Distributed Energy Resources*
- ❑ CEC has a on-going Technology Partnership with LBNL-CERTS on *micro-grid development*
- ❑ CEC also coordinates with DOE on *Distributed Energy and Electric Distribution Transformation Programs*